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LOW-PRESSURE SPRAY MODULE AND METHOD FOR LOW-PRESSURE SPRAY CLEANING INCLUDING RESIDUAL CONTAMINANT ANALYSIS OF COMPONENTS

Background Information

The present invention is directed to a method for low-pressure spray cleaning and residual contaminant analysis of components using a low-pressure spray module.

At the present time, residual cleaning and residual contaminant determination of components is performed using the dipping method including ultrasonic testing, if necessary. Using such a method, it is possible to ensure that the outer surfaces in particular of components are cleaned. In contrast, the cleaning effect in internal areas of components, e.g., through holes or blind holes, is not ensured in every case. In some cases, wash stands are also used for cleaning in which a cleaning medium is pumped through the component in a closed circuit at high pressures using adapters.

Accordingly, the described known methods for residual cleaning and residual contaminant determination of components have the disadvantage that in many cases, it is not possible or is very difficult to clean through holes and blind holes, the cleaning modules used are usually only adapted to specific component geometries, and they frequently require a costly filtering method due to the closed circuit of the flushing medium.

Object and Advantages

Therefore, the object of the present invention is to avoid the described disadvantages and specify a method for low-pressure spray cleaning and residual contaminant analysis, as well as a low-pressure spray module such that controlled internal cleaning of even poorly accessible areas such as through holes and blind holes is feasible using simple filter technology and the method is compatible with various component geometries.

The core of a low-pressure spray module which achieves the above object is that particle-free pressurization is carried out without a pump using a receiver tank which contains a flushing medium pressurized with compressed air, an exchangeable spray lance having a variable diameter, shape and length being attached on the outlet side of the receiver tank, it being possible to couple the spray lance to a metering diaphragm valve; if nozzles are used, external cleaning of the components is also possible and furthermore, the particle-containing flushing medium arising during the spray cleaning is collected in a collection tank in which an analysis filter is installed, which filters the particles out of the flushing medium and preserves them for later analysis.

A method for low-pressure spray cleaning and residual contaminant analysis of components, operating using such a low-pressure spray module, includes the following steps:

A: providing a receiver tank filled with a flushing medium;
B: pressurizing the receiver tank on the inlet side using compressed air from a compressed air source;
C: guiding the pressurized flushing medium from the receiver tank to a spray lance;
D: spray cleaning the component by spraying the flushing medium from the spray lance;
E: collecting the particle-containing flushing medium in a collection tank after the spray cleaning;

F: providing an analysis filter positioned on an outflow side of the collection tank in such a way that the particle-containing flushing medium flows through it;

G: filtering the particles out of the flushing medium using the analysis filter, and

H: analyzing the residual contamination filtered out by the analysis filter.

Preferably, filtering out of the particles by suction of the flushing medium is supported using a vacuum pump situated at the outflow side of the collection tank downstream of the analysis filter. The residual contaminant analysis of the particles filtered out may be performed by optical microscopy or scanning electron microscopy. These features provide the following advantages of the method and the low-pressure spray module of the present invention:

- controlled internal cleaning of poorly accessible areas in components, such as through holes or blind holes, by using exchangeable spray lances having matched geometry;
- variable pressure (e.g., 2 bar to 6 bar) settable or adjustable depending on the component;
- no costly filter technology due to open flushing circuit;
- filter produced specifically for cleanliness analysis to be performed using a scanning electron microscope or optical microscope;
- usable for various component geometries;
- dead volume-free, low particle system technology.

Exemplary Embodiment

Referring to the sole Figure 1, which shows the components essential to the present invention using a process flow chart, the following description describes an exemplary embodiment of the method of the present invention for low-pressure spray

cleaning and residual contaminant analysis, as well as a low-pressure spray module used for it.

According to Figure 1, a low-pressure spray module is used according to the present invention, the main components of which include a receiver tank B1 which is pressurized using compressed air from a compressed air source (line 1), the receiver tank being filled with a flushing medium (via a line 2), a spray lance S1 connected to the outlet side of receiver tank B1 via a prefilter F1 and being in flushing medium communication with receiver tank B1 via the flushing medium, a collection tank B2, an inline analysis filter F2 which is connected to collection tank B2 via a line 5 and which filters out particles from the particle-containing flushing medium from collection tank B2 after the component is washed and preserves them for later analysis, and a vacuum pump (not shown) connected via a line 6. All system parts are preferably made of stainless steel and are dead volume-optimized.

Receiver tank B1 is first filled with a filtered flushing medium via line 2. It may be operated by connecting it to a compressed air system (line 1), existing in the factory, as a compressed air source at a maximum pressure of approximately 6 bar. The tank pressure is controlled or regulated by a valve V1 located in compressed air line 1. The flushing medium may also be supplied to long through holes via spray unit S1 having a lance. To ensure the necessary movability of flushing lance S1, flushing lance S1 is connected to prefilter F1 via a flexible hose 4. A second regulating/setting valve V2 is located in line 3 between prefilter F1 and receiver tank B1 for a requirements-based regulation/setting of the pressure and/or the volume of the flushing medium to prefilter F1 or to flushing lance S1. The exchangeability of spray lance S1, the diameter and length of which may vary depending on the component, and flexible line 4 make it possible to flush,

i.e., spray out, components of complex design, i.e., including through holes and blind holes produced in the component from different sides.

The particle-containing flushing medium is collected in receiver tank B2 after the components are sprayed out. To that end, the upper opening of collection tank B2 advantageously widens toward the top in the shape of a funnel. The particle-containing medium collected in collection tank B2 is drawn off via inline analysis filter F2 using the vacuum pump (not shown). Immediately afterwards, it is possible to examine the produced filter and analyze it for the determination of residual contamination.

An alternative not included by the present invention would be to generate the pressure for the flushing medium via pumps, which would necessitate a costly filter technology for the flushing medium in order to ensure that it would have high purity. Furthermore, a high pressure drop arises, which must be accounted for in the pump power output. In contrast, an open circuit is used in the method of the present invention in which the pressure is variable in a simple manner and no costly filter technology is needed.

The method described for low-pressure spray cleaning and residual contaminant analysis of components and the low-pressure spray module used for it has so far been tested successfully on components having purity-critical internal areas such as, for example, high pressure pumps for diesel injection systems, injection nozzles, hydraulic power units for ABS systems, and other components of motor vehicle injection systems.